Volume 26 Article 5

1-1-1938

Determination of Normal Fire Danger

H. T. Gisborne
Northern Rocky Mountain Forest and Range Experiment Station

Determination of Normal Fire Danger

By H. T. GISBORNE
Senior Silviculturist, Northern Rocky Mountain Forest and Range Experiment Station

EVERY forest executive responsible for the protection of forest lands is confronted with the task of planning fire control facilities and action adequate for his area. These facilities and actions will be greatly different in Vermont—the state without a drought—from those required in some other parts of the country where nearly every summer brings a two-month or longer drought. In the various sections of the United States the fire control facilities and action justifiable will vary according to what might be called the normal fire danger of that section. As the cost of these facilities and action may vary from a few mills to several cents per acre per year, it behooves the forest executive to plan carefully. If he underestimates fire danger, he is likely to get burned out. If he overestimates, and overspends, his boss will very likely "burn him up."

When forest fire research was first commenced in 1916 and 1917, the pioneer researchers, S. B. Show, J. A. Larsen, C. C. Delavan, J. V. Hofmann, and W. B. Osborne, all drove toward the same goal: indices of fire danger. Some selected wind, some advocated humidity alone, some tried all the weather elements, but both Show and Larsen commenced investigations of duff moisture and inflammability. In those days no one spoke of the "fuels" of forest fires, but when Show and Larsen measured the moisture content of forest duff, and tested its ignitibility with a match, they were studying specific fuels and they were originating a phase of research which is now being pursued in several sections of the country.

AT THE Northern Rocky Mountain Forest and Range Experiment Station later studies of duff moisture resulted in

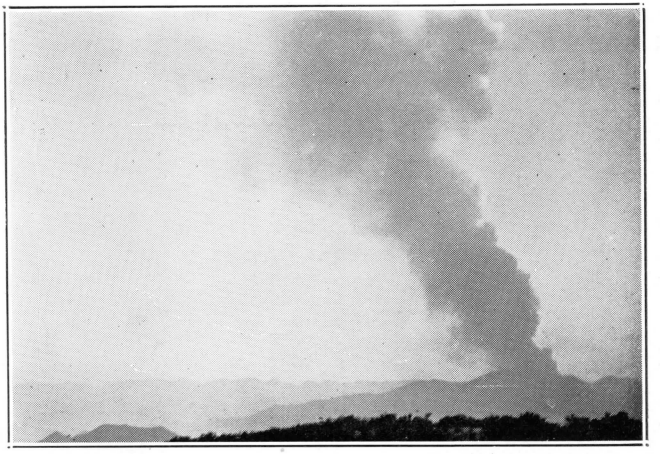
the invention of the duff hygrometer for measuring the moisture content of this fuel. These studies also pointed to the importance of other fuels such as dead branchwood, and the wood cylinder or "stick" method of measuring wood moisture was therefore originated. With duff hygrometers and wood cylinders available, it was found easier to measure this inflammability factor of fire danger directly rather than measure all the important weather factors and then attempt to determine fuel moisture by integration.

Northern Rocky Mountain Station studies of fire behavior also vindicated the research pioneers who had stressed the importance of wind. These studies showed clearly that rate of spread of fire varied not only with fuel moisture but also with wind. Consequently, fuel moisture alone could not be used as a dependable index of fire danger. Wind velocity also must be considered.

Analyses of the fire records also proved that, in the Northern Rocky Mountain region, lightning must be included in the danger rating scheme. And, as more lookouts are needed when atmospheric transparency is reduced by smoke, dust, mist, and fog, some allowance must be made for visibility, if the danger index is to be used as a guide to the action that a fire control executive must take in protecting his property.

Obviously, no instrument was needed for measuring the occurrence of lightning, but new instruments were needed for measuring wind velocity and visibility distance. Standard anemometers at $80 or more per instrument were out of foresters' financial reach so the Northern Rocky Mountain Station originated a cheap device for measuring wind. Recently a manufacturer has been found able to produce an even more accurate instrument at less than $5 each. In the meantime the Pacific Northwest Forest and Range Experiment Station invented a visibility meter and the Northern Rocky Mountain Station followed with a similar device so that visibility distance can be measured instead of estimated.

FROM this research there was consequently made available to the forest executive a selected list of the essential factors of fire danger and instrumental methods for measuring each of them. This still left to executive judgment, however, the integration of all these factors into a terminology or scale which would indicate the fire control action needed. To solve this



basic problem the Northern Rocky Mountain Station adopted a mechanical device used by photographers, called an exposure meter, and produced the first fire danger meter. This device provided a consistent method of integrating the essential factors of fire danger into a numerical rating on a scale of 1 to 7.

By this scale of fire danger class 1 includes all combinations of season, lightning, visibility, fuel moisture, and wind such that fires will not spread and no men need be employed for fire control. At the other extreme, class 7 includes such conditions as mid-July and August vegetative development, lightning within past two days, visibility distance restricted to less than 4 miles, fuel moistures under 5 percent, and winds of 8 miles an hour or more. If fuel moistures are between 5 percent and 7 percent and the wind 25 m. p. h. or more, with other factors as above, the day is also rated as class 7. Under all such conditions fires not immediately controlled can be expected to "blow up" and spread at rates of 1,500 to 2,000 acres *per hour* in most of the timber types of this region.

This numerical scale of fire danger therefore offers the forest executive a methodical and measured determination of forest fire danger upon which he may more dependably base his opinion of the "normal danger" to which his forest is exposed. Without such integrated measurements he must guess and take his chances of getting burned out or burned up.

THE Northern Rocky Mountain Region of the Forest Service is the only one having such measurements for a period of years. Other Regions have barely begun or have yet to commence accumulating such data. For Region One there are in fact good data for only four years, 1934 to 1937, inclusive, and this is clearly inadequate for establishing a true "normal" or median in the sense of the terms as used by meteorologists. The available data reveal a consistency, however, which is obviously indicative. Furthermore, in this region there is a colloquial axiom to the effect that "There is no such thing as a normal fire season." Every season differs from every other in one or more significant respects.

The consistency of the Region One data is apparent in table 1, which shows the number of days of each class of fire danger during July and August, on a typical north Idaho or western Montana National Forest.

TABLE 1. Number of days of each class of fire danger, July and August

	Class of danger						
Year	1	2	3	4	5	6	7
	Number of days						
1934	0.0	0.7	4.5	17.1	29.3	9.8	0.6
1935	0.1	4.0	9.1	21.1	24.6	3.0	0.1
1936	0.0	1.8	6.5	20.1	27.9	5.6	0.1
1937	0.0	3.5	16.3	34.7	7.5	0.0	0.0
Average	0.02	2.50	9.10	23.25	22.32	4.60	0.2
Standard error	0.00	0.33	0.80	1.43	1.40	0.95	0.09

As shown both by the yearly data and the averages in table 1, the executive cannot depend upon a single day of absolute safety from fire during July and August in this region. He can normally expect only two or three days of class 2, or very low danger. Forty-five days or nearly 75 percent of this period will be class 4 or class 5 danger: average or a little higher. He must be prepared to build up his organization for four or five days each July 1 to August 31 to meet class 6 danger when great damage may be expected unless fires are discovered almost immediately after origin, and extinguished with exceptional dispatch. Fortunately, he has a probability of only 3 in 1,000 of experiencing class 7 danger, when every conceivable precaution must be taken to prevent fires from starting.

At present in Region One of the Forest Service, the manpower needed on a million-acre National Forest would be provided for each class of danger about as follows: Class 1, no men, class 2—4 men, class 3—12 men, class 4—82 men, class 5—128 men, class 6—220 men, class 7—220 men plus prayers. When conditions are such that fires can spread at 1,500 to 2,000 acres per hour, the fire control executive is in about the same position as the football coach who has used his best punts and passes and still has not definitely won the game; the best that he can do for the remainder of the game, or fire season, is to pray for a lucky break.

It is apparent, nevertheless, that in order to benefit by methodical, dependable planning the executive *must* know how his fire danger is likely to vary throughout a season. This can be approximated by records of number of fires over a period of years, but such an approximation has two basic weaknesses. First, the causative agencies—man and lightning—are not uniformly active from year to year. Man may be persuaded to decrease his activities; lightning is uncontrollable, unpredictable except from day to day and may—actually has—overloaded a Forest with more fires in one day than the records for the previous 10 years had indicated as probable for a whole season. Second, the causative agencies may vary their activity as they will, but the weather may either increase or decrease their effectiveness. For example, an influx of careless tourists may result in double the number of campfires left burning, cigarette snipes thrown glowing into the forest, matches carelessly flipped without being extinguished, yet the number of man-caused fires may *decrease*, solely because abundant and frequent rains kept the forest fuels too wet to burn. Consequently, the old criteria of number of fires is a poor basis for judging the fire load. Burned area, of course, is even less dependable because an efficient fire control executive will hold down his burned area even during critical seasons, while an inefficient executive may allow a large acreage to be burned even in a season of only average danger.

The results of forest fire research therefore now offer to the forest executive accurate methods of determining current fire danger, of judging past danger, and for estimating the normal danger that must be known in order to provide adequate facilities and manpower.